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Performance Analysis of Online Bookstores by Using MACBETH and PROMETHEE Methods

İnternet üzerinden satış yapan kitabevlerinin performansların MACBETH ve PROMETHEE yöntemleriyle analizi

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With the developing technology Internet usage is becoming widespread in many areas. As Internet usage evolves, people prefer to shop online in order to meet their needs. Therefore, at this point they will be faced with decision making process. So as to analyze the performance of various alternatives multiple decision making methods is utilized. In this paper the performance of four different online bookstores were analyzed. Price, security, lead time, product range and customer care were determined as evaluation criteria. MACBETH and PROMETHEE methods were in use on behalf of comparing performances of shopping websites. In MACBETH it is not necessary to use another method in order to calculate weights of criteria whereas in PROMETHEE AHP (Analytic Hierarchy Process) method was used. This study differentiates itself by the methods it used which are rarely applied in Turkey.

Keywords: *Multiple Decision Making Methods, MACBETH, PROMETHEE, E-commerce*

Jel Codes: *C02, C44, C61.*

Gelişen teknoloji ile İnternet kullanımı birçok alanda yaygınlaşmaktadır. İnternet kullanımı arttıkça insanlar ihtiyaçlarını karşılamak için alışverişlerini İnternet üzerinden yapmayı tercih etmektedirler. Dolayısıyla ihtiyaçları karşılama noktasında karar verme süreciyle karşılaşılabilmektedir. Çeşitli alternatifler arasından performanslarının değerlendirilmesi için çok kriterli karar verme yöntemlerinden faydalanılmaktadır. Bu çalışmada İnternet üzerinden kitap satışı yapmakta olan dört sitenin performansları incelenmiştir. Değerlendirme kriterleri olarak fiyat, güvenilirlik, teslimat hızı, ürün çeşitliliği ve müşteri hizmetleri belirlenmiştir. Alışveriş sitelerinin performanslarının karşılaştırılması için çok kriterli karar verme yöntemlerinden MACBETH ve PROMETHEE kullanılmıştır. Kriterlerin ağırlıklarının hesaplanması için MACBETH yönteminde ayrı bir yöntem gerekmezken, PROMETHEE için ayrıca AHS (Analitik Hiyerarşi Süreci) yönteminden faydalanılmıştır. Çalışma Türkiye'de çok az uygulanan yöntemlerden faydalandığı için diğer çalışmalardan farklılaşmaktadır.

Anahtar Kelimeler: *Çok kriterli karar verme yöntemleri, MACBETH, PROMETHEE, E-ticaret*

Jel Kodları: *C02, C44, C61.*

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1. INTRODUCTION

In recent years with the developing technology Internet usage is becoming widespread in many areas. As Internet usage evolves, people prefer to shop online in order to meet their needs. Various companies use Internet as a branch of sales marketing. They try to reduce personal, rental expense etc. by being an online store. Therefore the prices are cheaper than the price of offline stores. Consequently, consumers tend to buy products from online stores. But lots of websites that provide services exist on the web. Consumers are doubtful about which alternative is much more secure, efficient etc. At this point they will be faced with decision making process. So as to analyze the performance of various alternatives multiple decision making methods are utilized.

Multi-criteria decision analysis (MCDA) methods have been developed as decision support tools to help aggregate quantitative and qualitative information and to take into account the preference of one or multiple decision makers (Frenette et al., 2010: 33). MCDA is widely used decision methodology that considers contradictory problems of criteria (Dhouib, 2014: 25). Decision makers prefer to use operational research methods that simplify the problem and guide decision maker to rank the alternatives in terms of specific criteria. Therefore in various fields MCDA methods can be applied effectively. Especially numerous methods were used for analyzing the performance of websites in literature as below:

Ngai (2003) applied AHP to select the best website for online advertising in terms of impression rate, monthly cost, audience fit, content quality and "look and feel". Cao et al. (2005) defined the factors that constitute website quality by using SERVQUAL. Although the main components are functionality, content, service and attractiveness, they indicated that information, system and service quality play an important role. Büyüközkan et al. (2007) made an assessment of e-learning websites by a group decision making. Although the writers used VIKOR method based on fuzzy environment, they didn't prefer to use fuzzy logic in the first stage of study. They used fuzzy logic in the subsequent phases of VIKOR method without losing important information. Ku & Fan (2009) used AHP method in order to determine the factors that affect the performance of travel agencies websites'. The writers used results of questionnaires. Therefore privacy, safety and product quality were determined as the most important factors. Tsai et al. (2010) proposed a model that evaluate national park websites. They first applied DEMATEL in order to cope with the interdependencies between criteria, secondly Analytic Network Process (ANP) was used to calculate the weights of criteria, finally so as to rank the websites of Taiwanese national park VIKOR method was used. Tsai et al. (2011) determined the effectiveness of airlines' websites according to marketing mix 4Ps and website quality. They utilized DEMATEL to analyze the relationship among criteria, ANP to compute the weights of each criterion and also VIKOR to evaluate the performance of each alternative. Wang et al. (2011) evaluated the archives websites' performance by utilizing interval intuitionistic fuzzy information based on TOPSIS. Thereafter according to weighted Hamming distance the relative closeness degree to the positive ideal solution was calculated in order to rank all alternatives. Chiu et al. (2013) proposed a new hybrid model that combine DEMATEL, DEMATEL based ANP and VIKOR to reduce the gaps in customer satisfaction caused by interdependence and feedback problems among dimensions and criteria and to achieve the aspiration level. The writers asserted this research could help e-store managers to improve marketing strategies. Schäfer

& Kummer (2013) provided an effectiveness evaluation instrument for corporate websites. The evaluation approach aligns marketing analysis with web mining approaches. As a result the writers said that the model support customer value determination and enable customization for different relational marketing strategies. Bastida & Huan (2014) compared four tourism websites in terms of quality and usefulness. The websites assessed according to 23 items and "website customer usefulness rubric" method was used for evaluation. Wu & Guo (2015) searched the performance of provincial government website in China by data envelopment analysis (DEA). As a result general performance of e-government websites found inefficient level. Kang et al. (2016) presented a new integrated model which consist E-S-QUAL and fuzzy hierarchical TOPSIS to evaluate B2C e-commerce websites. As a result preference order obtained and sensitivity analysis of ranking conducted.

In this paper the performance of four different online bookstore will be analyzed in terms of lead time, customer care, price, security, and product range. As a method MACBETH and PROMETHEE will be in use on behalf of comparing performances of shopping websites. In addition AHP method will be exploited for determining the weights of criteria in PROMETHEE. In the next part in order to show the process of methods respectively MACBETH, PROMETHEE and AHP will be explained. Thereafter the application of these models to online websites will be discussed.

2. METHODS

In literature various methods were used in order to evaluate the performance of different kinds of websites as it can be seen from the previous section. For this reason in this paper MACBETH and PROMETHEE that are used rarely in literature were chosen as methods. Moreover by choosing these two methods, it can be considered whether the result of qualitative and quantitative methods vary or not.

2.1. MACBETH

MACBETH (Measuring Attractiveness by a Categorial Based Evaluation Technique) a multi-criteria decision making method was presented by C. A. Bana e. Costa and J. C. Vansnick in 1994. MACBETH is an interactive approach for quantifying value judgements about the elements of a finite set (Bana e Costa & Vansnick, 1997a: 107). This method defines quantitative performance expression and aggregation from qualitative pairwise comparisons of situations based on decision maker (Clivillé et al., 2007: 173). MACBETH enables facilitators to avoid forcing decision makers to produce numerical representations of their preferences (Ertay et al., 2013: 40).

In this method, it is possible to analyze a hierarchy of alternatives organized according to their levels of attraction for decision maker. Therefore first of all decision maker needs to determine decision criteria in order to select the most appropriate alternative (Karande & Chakraborty, 2013: 262). Chosen criteria compose a value tree which present decision making process visually.

Secondly for evaluating the performance of alternatives the decision maker needs to compare two stimuli at a time with qualitative judgements about their difference of attractiveness based on a semantic judgement scale (Karande & Chakraborty, 2013: 262). Let a and b are two stimuli in a MACBETH problem. Decision maker is asked to answer the difference of attractiveness between a and b. So, aPb shows that a is more attractive than b, however the level of attractiveness is crucial in assessment. The categories of the attractiveness between criteria are shown in Table 1 as below (Bana e Costa & Vansnick, 1997b: 17).

Table 1. Semantic Categories

Categories	Semantic Judgement Scale	Quantitative Scale (h)
-	Null	0
C_1	Very Weak	1
C_2	Weak	2
C_3	Moderate	3
C_4	Strong	4
C_5	Very Strong	5
C_6	Extreme	6

The comparison process is called questioning procedure of MACBETH. Although each question involves only two stimuli, it is easy to derive from the set of absolute judgements. For instance Table 2 shows the semantic judgements (Bana e Costa & Vansnick, 1999: 136).

Table 2. Matrix of Judgements

	A (Good)	B	C	D	E	F (Neutral)
A (Good)	Null	Very weak	Weak	Moderate	Very strong	Extreme
B		Null	Weak	Strong	Very strong	Extreme
C			Null	Weak	Moderate	Very Strong
D				Null	Very Weak	Strong
E					Null	Moderate
F (Neutral)						Null

First of all pairwise comparison of DMU's in terms of each criteria are made, thereafter in order to determine weights of criteria the comparison of criteria are made by decision maker. As construction of the matrix of judgements is feasible in EXCEL, M-MACBETH software based on the implementation of MACBETH methodology was developed. M-MACBETH software has an advantage since it tests the compatibility of information collected with regard to cardinal information. When incompatible judgements are detected, the software gives a warning message. Thereafter it provides suggestions to overcome inconsistency (Bana e Costa et al., 2005). In order to avoid inconsistency comparison units should be placed in matrix in descending order. Therefore two of comparison units should be considered as the "good" or "neutral" level as that can be seen in Table 2.

Consequently decision maker makes [n*(n-1)]/2 number of comparisons for n units in each category. By the help of M-MACBETH software the strength of comparisons shown in Table 1 are taken as a measurement. If the decision maker prefers performance of B over D with a strength $h \in \{0,1,\ldots,6\}$,

Then,

$$v(B) - v(D) = h\alpha , \quad (1)$$

where α is a coefficient necessary to meet the condition that v(B) and v(D)$\in$ [0,100] (Karande & Chakraborty, 2013: 264).

In the background of M-MACBETH Eq. (1) will be constituted for each comparison in each matrix. Thereafter α and the total score of units will be obtained by the additive value model as below (Karande & Chakraborty, 2013: 264):

$$\left.\begin{array}{l} V(X_i) = \sum_{j=1}^{n} w_j(v_j) \\ \sum_{j=1}^{n} w_j = 1,\ w_j > 0 \end{array}\right\} \qquad (2)$$

$v_j(x_j^+) = 100$ (Good Level)

$v_j(x_j^0) = 0$ (Neutral Level)

w_j = the weight of j[th] criterion

By calculating the overall scores of units, decision makers can easily decide which option is much more important in terms of determined criteria.

2.2. PROMETHEE

The PROMETHEE I (partial ranking), PROMETHEE II (complete ranking) were developed by J. P. Brans in 1982. Thereafter PROMETHEE III (ranking based on intervals) and PROMETHEE IV (continuous case) were developed by J. P. Brans and B. Mareschal. In addition same authors proposed the visual interactive module GAIA which provides graphical presentation based on PROMETHEE methodology. In 1992 and 1994 J. P. Brans and B. Mareschal suggested two extensions: PROMETHE V (including segmentation constraints) and PROMETHEE VI (representation of the human brain) (Brans & Mareschal, 2005: 164).

PROMETHEE (Preference Ranking Organization Method for Enrichment Evaluations) proceeds to a pairwise comparison of alternatives in terms of each criterion in order to determine the strength of preference of an alternative one over the other. The application of PROMETHEE requires numerical data and two additional information, namely (Rao & Patel, 2010: 4666):

- Information on the relative importance of the criteria (The weights of criteria)
- Information on the decision maker's preference function, which he/she uses when comparing the contribution of the alternatives in the sense of each criterion

Additionally few considerations that should be taken into account while using PROMETHEE are given as below (Keyser & Peeters, 1996: 460):

- Decision maker can express preference between two alternative in terms of all criteria.
- Decision maker can determine ratio scale which shows the importance of criteria.
- Decision maker is aware of the fact that the weights are representing trade-offs.
- The difference between evaluations of criteria must be meaningful.
- None of the possible differences on any of the criteria can give rise to discordance.

The first main point of PROMETHEE is the weights of criteria. But as a drawback of this method specific guidelines for determining the weights of criteria aren't provided (Macharis et al., 2004: 308). Therefore in contrast to MACBETH, PROMETHEE needs a separate method that helps to calculate the weights of criteria. Among various methods AHP is the most commonly used model which is capable of handling so many criteria (Anand & Kodali, 2008: 48). Thereby AHP method will be embraced in next section.

The second main point of the method is determining the preference function of decision maker for an alternative a with regard to b. This function will be determined separately for each criterion and its value interval is 0 and 1 ($0 \le P_j(a,b) \le 1$). The smaller the function, the greater the indifference of the decision maker; the closer to 1 the greater his preference (Brans & Vincke, 1985: 649). Six types of generalized PROMETHEE preference function are shown in Table 3 (Brans et al., 1986: 229-231).

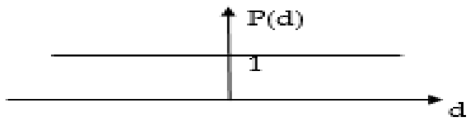
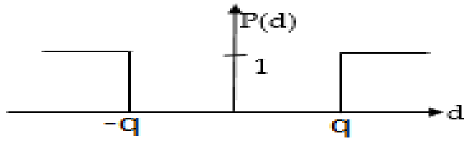
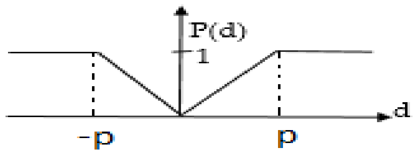
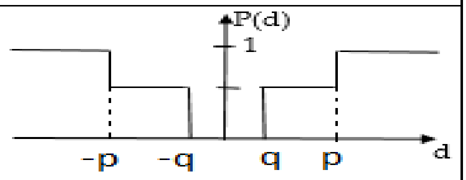
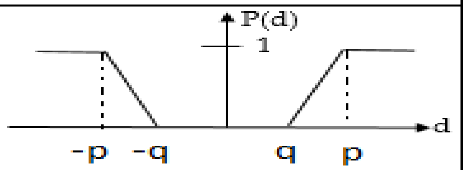
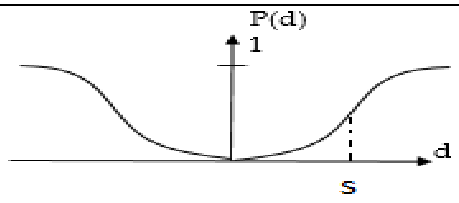
Function Type	Preference Function
Type 1: Usual Criterion $P(d)=\begin{cases} 0 & d=0 \\ 1 & \lvert d\rvert = 1 \end{cases}$	
Type 2: U-shape Criterion $P(d)=\begin{cases} 0 & \lvert d\rvert \le q \\ 1 & \lvert d\rvert > q \end{cases}$	
Type 3: V-shape Criterion $P(d)=\begin{cases} \frac{\lvert d\rvert}{p} & \lvert d\rvert \le p \\ 1 & \lvert d\rvert > p \end{cases}$	
Type 4: Level Criterion $P(d)=\begin{cases} 0 & \lvert d \le q\rvert \\ \frac{1}{2} & q < \lvert d\rvert \le p \\ 1 & \lvert d\rvert > p \end{cases}$	
Type 5: Linear preference and indifference area $P(d)=\begin{cases} 0 & \lvert d\rvert \le q \\ \frac{\lvert d\rvert - q}{p-q} & q < \lvert d\rvert \le p \\ 1 & \lvert d\rvert > p \end{cases}$	
Type 6: Gaussian Criterion P(d)= 1- $e^{(-d^2/2\sigma^2)}$	

Figure 1. Preference Function Types (Brans et al., 1986: 229-231)

Let A be a set of alternatives and g_j (a) is the value of j^{th} criterion (j=1, 2,…,n) of alternative a ∈ A. d_j (a,b) is the difference of the deviations between the evaluation of the alternatives. The difference of the deviations are considered since PROMETHEE is based on pairwise comparison. If deviation is small, the decision maker will allocate a small preference to the best alternative. The larger the deviation, the larger the preference. The preference function can be seen as below (Brans & Mareschal, 2005: 169):

$$P_j(a,b) = F_j \lfloor d_j(a,b) \rfloor, \ \forall a,b \in A \tag{3}$$

$$d_j(a,b) = g_j(a) - g_j(b) \tag{4}$$

$P_j(a,b) \in [0,1]$ is calculated by using predefined function and two important thresholds (q_j indifference and p_j preference thresholds). Indifference threshold (q_j) is the largest deviation to consider as negligible on j^{th} criterion. This value is small in terms of the scale of measurement. On the other hand preference threshold (p_j) is the smallest deviation to consider decisive in the preference of one alternative over another. In contrast to indifference threshold, preference threshold is large value with respect to the scale of measurement. In addition Gaussian threshold (s) is the other parameter which is only used with Gaussian preference function. This value is in the interval of indifference and preference thresholds (Wang & Yang, 2007: 3694).

For each pair of alternatives, a preference function $P_j(a,b)$ that presents preference level of a to b on j^{th} criterion can be defined as below (Araz & Ozkarahan, 2007: 590):

$$P_j(a,b) = 0 \text{ if } d_j(a,b) \le q_j, \tag{5}$$

$$P_j(a,b) = 1 \text{ if } d_j(a,b) \ge p_j, \tag{6}$$

$$0 < P_j(a,b) < 1 \text{ if } q_j < d_j(a,b) < p_j \tag{7}$$

Let the preference function have been specified as P_j, and the weight of j^{th} criterion is w_j (j=1, 2,…n) of the problem. The preference index for each couple of alternatives can be calculated as follows (Araz & Ozkarahan, 2007: 590):

$$\pi(a,b) = \sum_{j=1}^{n} w_j P_j(a,b) \tag{8}$$

The preference index $\pi(a,b)$ is a measure for the intensity of preference of the decision maker for an alternative a in comparison with an alternative b for the simultaneous consideration of all criteria. This index shows a weighted average of preference function. The leaving flow (Φ^+) as a measure for strength of the alternatives and the entering flow (Φ^-) as a measure for weakness of alternatives are calculated (Geldermann et al., 2000: 51-52):

$$\Phi^+(a) = \frac{1}{T-1} \sum_{X \in A} \pi(a,b) \tag{9}$$

$$\Phi^-(a) = \frac{1}{T-1} \sum_{X \in A} \pi(b,a) \tag{10}$$

$$\Phi^{net}(a) = \Phi^+(a) - \Phi^-(a) \tag{11}$$

Eq. (9) and (10) show partial ranking of alternatives. These type of calculations in PROMETHEE I offers the decision maker a graph in which some actions are comparable while some others are not (Brans & Vincke, 1985: 653). In addition the leaving flow $\Phi^{+}(a)$ shows how a dominates all other alternatives of A, whereas the entering flow $\Phi^{-}(a)$ shows how a is dominated by all other alternatives of A (Wang & Yang, 2007: 3694). In case a complete ranking has been requested by the decision maker PROMETHEE II helps to calculate net flows (Brans & Vincke, 1985: 654). Therefore Eq. (11) shows the overall performance of alternatives.

2.3. Analytic Hierarchy Process (AHP)

Analytic Hierarchy Process (AHP) was found out in 1968 by Myers and Alpert, then it was developed in 1977 by Saaty. AHP makes the problem simple and more assessable by separating it in sub-problems (Bhushan & Rai, 2004: 15). AHP is one of the widely used multi-criteria decision making methods. This method based on the operation of managerial decision making for analyzing complex problems by giving the relative importance values to alternatives and criteria (Ertuğrul & Özbay, 2013: 90). AHP is a benefit scoring model that relies on subjective managerial inputs on multi-criteria. These subjective inputs state the evaluation of possible alternatives (Hanfield et al., 2002: 75). In AHP the decision maker estimates pairwise comparison ratios according to the strength of preference between decision making units (Sugihara et al., 2004: 745). Therefore AHP can solve decision problems by prioritizing alternative decision making units (Gass & Rapcsak, 2004: 573).

In AHP model the problem is defined as a hierarchy of criteria, sub-criteria and alternatives (Chandran et al., 2005: 2235). On the top of the hierarchy the objective of a problem is located. The general objective of a decision making problems is ranking alternatives in terms of criteria. The model consist three fundamental principles: hierarchy structure, matrix that include pairwise comparisons and consistency calculation (Ertuğrul & Tanrıverdi, 2013: 43).

In this model evaluation criteria are as follows: C = $\{C_j \mid j = 1,2,\ldots,n\}$ (Dağdeviren, 2008: 399). After determining the hierarchical structure alternatives can be evaluated in terms of criteria by decision makers. Therefore the matrix of pairwise comparisons a_{ij} (i, j = 1,2,..,n) shows the extent that one element is preferred over another in achieving an objective of one level higher in the hierarchy (Zahedi, 1986: 347). The comparison matrix that is $n \times n$ square matrix is denoted by A can be seen as below (Salmeron & Herrrero, 2005: 7):

$$A = (a_{ij}) = \begin{bmatrix} 1 & a_{12} & \ldots & a_{1n} \\ a_{21} & 1 & \ldots & a_{2n} \\ \ldots & \ldots & \ldots & \ldots \\ a_{n1} & a_{n2} & \ldots & 1 \end{bmatrix} \qquad (i, j = 1, 2,.., n) \qquad (12)$$

The elements of the matrix a_{ij} satisfy the conditions as follow (Chang et al., 2007: 299):

$$a_{ii} = 1,\ a_{ij} = \frac{1}{a_{ji}},\ a_{ij} > 0 \qquad (13)$$

The comparison matrix is formed by using 1-9 scale that is developed by Saaty. 1-9 Scale are given in Table 3.

Table 3. 1-9 Scale of Saaty (Saaty, 1987: 163)

Intensity of Importance on an absolute scale	Definition
1	Equal importance
3	Moderate importance of one over another
5	Essential or strong importance
7	Very strong importance
9	Extreme importance
2,4,6,8	Intermediate values between two adjacent judgments

The third part of AHP is the prioritizing the alternatives. Therefore after forming the comparison matrix each element is divided by the total of each column in order to have normalized matrix. Thereafter arithmetic mean of each row of normalized matrix are calculated that is $w = \{w_1, w_2, ..., w_n\}$. Although these weights show that the ranking of criteria based on expert opinion, they must be verified whether the the result is consistent or not. Thereby eigenvector is calculated so as to use in consistency index (Saaty & Vargas, 2001: 8).

$$Aw = \lambda_{max} w \tag{14}$$

λ_{max} is the largest eigenvalue of A. Saaty thought that λ_{max} may be considered the estimation of n. This means that if λ_{max} close to the value of n, the matrix will be more consistent (Zahedi, 1986: 348).

The consistency index (CI) can be calculated as follows:

$$CI = \frac{\lambda - n}{n-1} \tag{15}$$

If CI is rather large, it is recommended that the given pairwise comparison ratios should be adjusted by the decision maker (Sugihara et al., 2004: 746).

Table 4. Random Index (Saaty, 2008: 264)

n	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
RI	0	0	0,52	0,89	1,11	1,25	1,35	1,40	1,45	1,49	1,52	1,54	1,56	1,58	1,59

Finally the consistency ratio (CR) is calculated by dividing CI to RI which is shown as above in Table 4 based on the number of criteria (Brunelli, 2015: 25).

$$CR = \frac{CI}{RI} \tag{16}$$

CR shows whether the matrix that is formed by the decision maker is consistent or not by observing the value of CR is less than 0,10 or not. If CR ≤ 0,10, it can be said that comparison matrix has an acceptable consistency, if not the decision maker should revise the pairwise comparisons in the matrix (Zeshui & Cuiping, 1999: 444).

3. PERFORMANCE ANALYSIS OF ONLINE BOOKSTORES

This paper deals with the performance of online bookstores. Therefore multi-criteria decision making methods should be in use. As a method MACBETH and PROMETHEE are selected. Firstly, the process of MACBETH will be discussed then PROMETHEE and AHP respectively.

Because of the structure of multi-criteria decision making methods expert opinions are the key point of the evaluation. This paper takes the advantage of only single expert to determine relative comparison between criteria and alternatives.

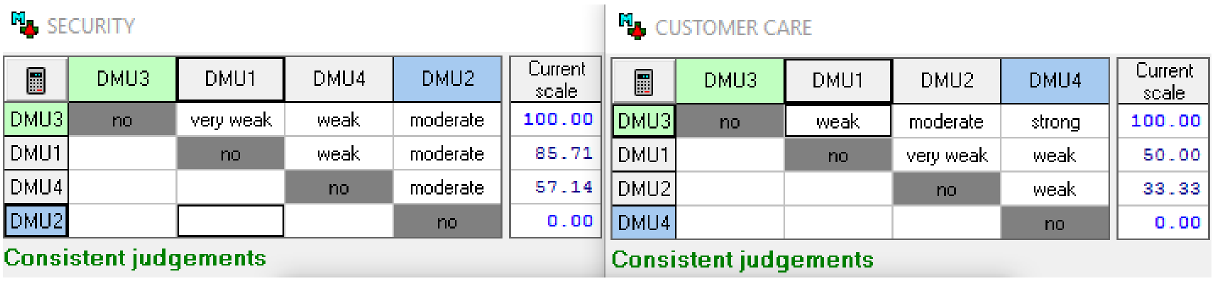
3.1. MACBETH Method

In MACBETH method M-MACBETH software was used but the same process was evaluated also in EXCEL and the verification was done. Oncoming parts outputs of M-MACBETH software was shown as a result. The first step of each multi-criteria decision making methods is determining each criterion related with problem. Therefore the structure of Value Tree can be seen as follow:

Figure 2. Value Tree

As alternatives four online bookstores were determined but the names of websites kept confidential. In the process of M-MACBETH the comparison matrix that consists alternatives was filled in terms of each criterion by the decision maker. M-MACBETH software provides the consistency of judgements. Therefore if decision maker judge contradictorily, the software can suggest alternative judgements. So using a software was preferred rather than using only EXCEL. In addition in order to make judgements easier, it is suggested that before pairwise comparison in terms of criteria, alternatives should rank and put in an order in matrix according to decision maker.

By the help of information explained above, each comparison matrix was formed by decision maker. First of all alternatives were evaluated in terms of security, customer care, price, lead time and product range. Thereby rankings of online bookstores were obtained separately and can be seen in Fig. 3, 4 and 5. In M-MACBETH software the scale of performance can be changed. But in this study 100 was determined as the best score, while 0 was the worst one.



SECURITY

	DMU3	DMU1	DMU4	DMU2	Current scale
DMU3	no	very weak	weak	moderate	100.00
DMU1		no	weak	moderate	85.71
DMU4			no	moderate	57.14
DMU2				no	0.00

Consistent judgements

CUSTOMER CARE

	DMU3	DMU1	DMU2	DMU4	Current scale
DMU3	no	weak	moderate	strong	100.00
DMU1		no	very weak	weak	50.00
DMU2			no	weak	33.33
DMU4				no	0.00

Consistent judgements

Figure 3. The Scores of Online Bookstores Based on Security and Customer Care

In Fig. 3 security and customer care are criteria in order to determine ranking of online bookstores. As a result of this evaluation in terms of security DMU3, DMU1, DMU4, DMU2 is the sorting, whereas in terms of customer care DMU3, DMU1, DMU2, DMU4.

PRICE

	DMU2	DMU1	DMU4	DMU3	Current scale
DMU2	no	weak	moderate	strong	100.00
DMU1		no	weak	moderate	66.67
DMU4			no	weak	33.33
DMU3				no	0.00

Consistent judgements

LEAD TIME

	DMU2	DMU1	DMU3	DMU4	Current scale
DMU2	no	weak	moderate	strong	100.00
DMU1		no	very weak	weak	50.00
DMU3			no	weak	33.33
DMU4				no	0.00

Consistent judgements

Figure 4. The Scores of Online Bookstores Based on Price and Lead Time

In Fig. 4 scales of online bookstores are shown according to price and lead time respectively. The decision maker compared each unit by putting in an order in matrix. So that according to price the decision maker stated that ranking should be DMU2, DMU1, DMU4, DMU3. In addition according to lead time uppermost wasn't change but remain part of ranking was DMU1, DMU3, DMU4. Therefore by pairwise comparison current scales of units were calculated.

PRODUCT RANGE

	DMU2	DMU3	DMU4	DMU1	Current scale
DMU2	no	very weak	weak	moderate	100
DMU3		no	weak	moderate	80
DMU4			no	weak	40
DMU1				no	0

Consistent judgements

Figure 5. The Scores of Online Bookstores Based on Product Range

In Fig. 5 the last criterion which is product range was used in order to evaluate online bookstores. The decision maker determined the ranking of online bookstores as DMU2, DMU3, DMU4, DMU1. By determining relative ranking of online bookstores current scales were calculated in order to use it to calculate overall performance of each unit.

Weighting (ONLINE BOOKSTORE)

	[PRICE]	[LEAD TIME]	[SECURITY]	[CUSTOMER CARE]	[PRODUCT RANGE]	[all lower]	Current scale
[PRICE]	no	very weak	weak	strong	v. strong	positive	31.82
[LEAD TIME]		no	weak	strong	v. strong	positive	29.55
[SECURITY]			no	strong	v. strong	positive	25.00
[CUSTOMER CARE]				no	weak	positive	11.36
[PRODUCT RANGE]					no	positive	2.27
[all lower]						no	0.00

Consistent judgements

Figure 6. Weights of Each Criterion

MACBETH method contains calculation that figure out the weights of evaluation criteria. So that the decision maker compared criteria dyadically in comparison matrix. As a result of pairwise comparison current scales of each criterion can be seen as above in Fig. 6. Current scales of criteria shows the weights of each criterion, so the total of them must be equal the best score 100. Consequently the most important criterion is price with 31.82, while the least one is product range with 2.27.

Table of scores

Options	Overall	PRICE	LEAD TIME	SECURITY	CUSTOMER CARE	PRODUCT RANGE
DMU2	67.43	100.00	100.00	0.00	33.33	100.00
DMU1	63.10	66.67	50.00	85.71	50.00	0.00
DMU4	25.80	33.33	0.00	57.14	0.00	40.00
DMU3	48.03	0.00	33.33	100.00	100.00	80.00
[all upper]	100.00	100.00	100.00	100.00	100.00	100.00
[all lower]	0.00	0.00	0.00	0.00	0.00	0.00
Weights :		0.3182	0.2955	0.2500	0.1136	0.0227

Figure 7. Overall Scores of Online Bookstores

From now on online bookstore were judged according to separate criterion. In order to determine the general ranking that focus on all criteria the weighted sum of scores was calculated. In Fig. 7 the ranking of online bookstores and the scores of them can be seen. Through this figure overall score of the best online bookstore (DMU2) is 67,43, whereas the worst one (DMU4) is 25,80. Consequently the overall ranking of online bookstores was obtained as DMU2, DMU1, DMU3, DMU4.

3.2. PROMETHEE Method

In contrast to MACBETH, PROMETHEE method depends on quantitative consideration from expert opinion. In order to evaluate online bookstores according to PROMETHEE, Visual PROMETHEE 1.4 Academic Edition was used. But this software has a drawback that it is not provide calculation of weights for criteria. Therefore AHP method was used for weighting of each criterion. The steps of AHP are as follow:

Table 5. The Comparison Matrix (AHP)

	PRICE	LEAD TIME	SECURITY	CUSTOMER CARE	PRODUCT RANGE
PRICE	1	3	5	7	9
LEAD TIME	0,33	1	3	3	5
SECURITY	0,20	0,33	1	3	5
CUSTOMER CARE	0,14	0,33	0,33	1	5
PRODUCT RANGE	0,11	0,20	0,20	0,20	1
TOTAL OF COLUMN	**1,79**	**4,87**	**9,53**	**14,20**	**25**

Firstly decision maker filled the matrix based on pairwise comparison with the help of 1-9 Scale that was shown in Table 3. In Table 5 at the end of rows the total of each column was added in order to form the normalized matrix by dividing each element to sum of the related column. So that, normalized matrix was calculated as below:

Table 6. The Normalized Comparison Matrix and The Weights of Criteria

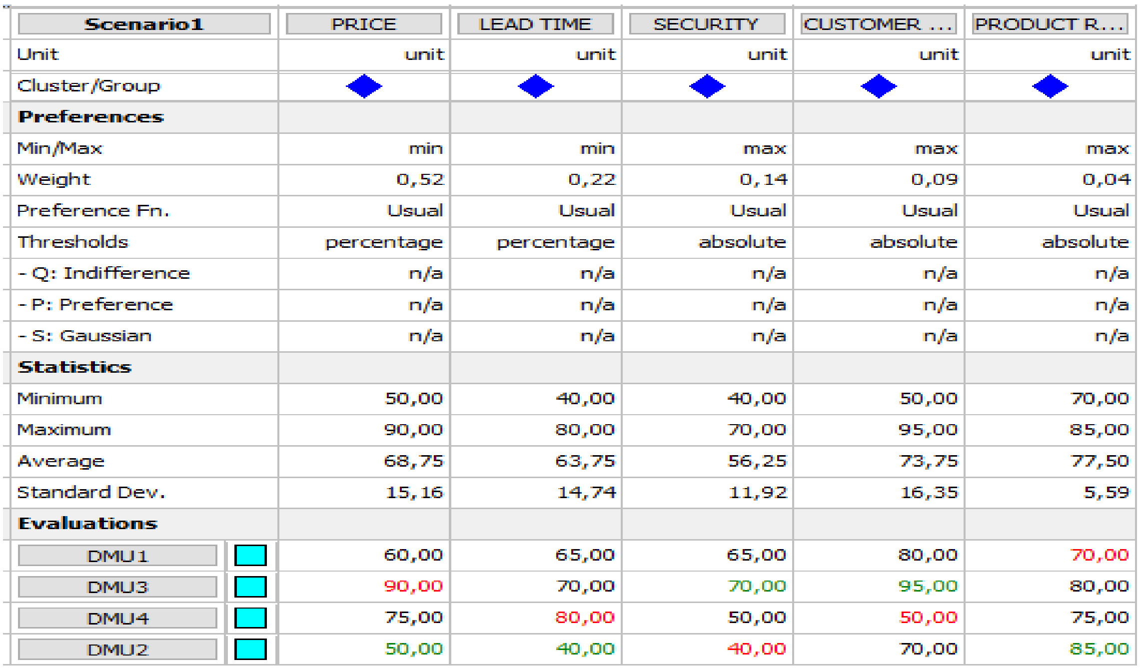
	PRICE	LEAD TIME	SECURITY	CUSTOMER CARE	PRODUCT RANGE	TOTAL OF ROW	WEIGHTS
PRICE	0,56	0,62	0,52	0,49	0,36	**2,55**	**0,51**
LEAD TIME	0,19	0,21	0,31	0,21	0,20	**1,12**	**0,22**
SECURITY	0,11	0,07	0,10	0,21	0,20	**0,70**	**0,14**
CUSTOMER CARE	0,08	0,07	0,03	0,07	0,20	**0,45**	**0,09**
PRODUCT RANGE	0,06	0,04	0,02	0,01	0,04	**0,18**	**0,04**

Secondly each row was sum up in normalized matrix. Thereafter so as to compute weights, total of each row was divided by the number of criteria which is 5. Consequently, the most important criterion was founded as Price with 0,51, whereas the worst one was Product Range with 0,04. Although the ranking of criteria was founded as same with the result of MACBETH, the weights of them wasn't.

Additionally the verification of calculated weights was made. Consistency index that was shown in Eq. (15) was founded as 0,09675 and by using Eq. (16) the value of CR was founded as 0,08716 which is less than 0,10. Consequently it can be said that judgements were consistent.

The calculated weights were used in PROMETHEE software. Fig. 8 shows the interface of the software. In this part each online bookstore was considered according to each criterion by giving 0-100 scores. Thereafter decision maker filled the preferences that consist min/max that is related with criteria, weights, the type of preference function.

For this study customers can prefer cheap and rapid service, therefore price and lead time was considered as minimum level, whereas security, customer care and product range was considered as maximum level. In addition by the help of explained preference function types, Usual Criterion (Type 1) was selected. At this point PROMETHEE software provides a guide to select the right preference function.



Scenario1	PRICE	LEAD TIME	SECURITY	CUSTOMER ...	PRODUCT R...
Unit	unit	unit	unit	unit	unit
Cluster/Group					
Preferences					
Min/Max	min	min	max	max	max
Weight	0,52	0,22	0,14	0,09	0,04
Preference Fn.	Usual	Usual	Usual	Usual	Usual
Thresholds	percentage	percentage	absolute	absolute	absolute
- Q: Indifference	n/a	n/a	n/a	n/a	n/a
- P: Preference	n/a	n/a	n/a	n/a	n/a
- S: Gaussian	n/a	n/a	n/a	n/a	n/a
Statistics					
Minimum	50,00	40,00	40,00	50,00	70,00
Maximum	90,00	80,00	70,00	95,00	85,00
Average	68,75	63,75	56,25	73,75	77,50
Standard Dev.	15,16	14,74	11,92	16,35	5,59
Evaluations					
DMU1	60,00	65,00	65,00	80,00	70,00
DMU3	90,00	70,00	70,00	95,00	80,00
DMU4	75,00	80,00	50,00	50,00	75,00
DMU2	50,00	40,00	40,00	70,00	85,00

Figure 8. The Evaluations in Promethee Software

Additionally in Fig. 8 statistics of the evaluation were calculated by software. Minimum and maximum scores, average of them and standard deviations can be seen as above. By specifying the type of min/max, scores can be judge whether it is the best score or not. With the help of these information entered Fig. 9 and 10 was obtained.

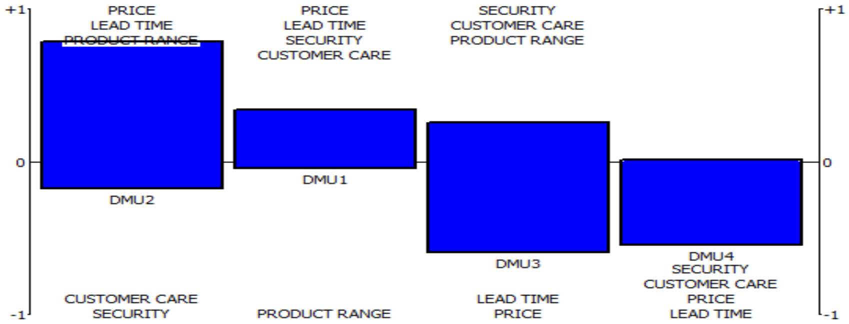


Figure 9. The Best and The Worst Criteria of Online Bookstores

Figure 9 demonstrates the graphic of each DMU and their situation for each criteria. For instance DMU2 has the minimum level of price, lead time and product range, whereas DMU3 has the maximum level of security, customer care and product range. In addition DMU4 has no maximum level of criteria, it has minimum level of criteria for instance: lead time, customer care.

Φ Preference Flows

	Phi+	Phi-	Phi
DMU1	0,6430	0,3570	0,2861
DMU3	0,3264	0,6736	-0,3472
DMU4	0,2292	0,7708	-0,5416
DMU2	0,8014	0,1986	0,6028

Figure 10. $\Phi^{+}, \Phi^{-}, \Phi^{net}$ Results of PROMETHEE

Fig. 10 indicates the results of PROMETHEE process. The values of $\Phi^{+}, \Phi^{-}, \Phi^{net}$ was calculated. Although Φ^{+}, Φ^{-} shows the partial ranking of alternatives, Φ^{net} represents overall performance ranking of alternatives. Eventually the ranking of online bookstores according to PROMETHEE was founded as DMU2, DMU1, DMU3, DMU4. It can be seen that the results of two different kind of multi-criteria decision making method are the same.

4. CONCLUSION

In this paper the ranking of online bookstores was evaluated by two different multi-criteria decision making methods which are MACBETH and PROMETHEE. MACBETH depends on qualitative, whereas PROMETHEE depends on quantitative judgements by experts. Therefore this study examined whether there is a difference between these two methods or not. In addition MACBETH method has an own tool that calculate the weights of criteria while in PROMETHEE has not. Consequently AHP method was used additionally in PROMETHEE. In this study four online bookstore was discussed in terms of five different criteria. As an evaluation criteria price, lead time, security, customer care and product range were determined. Ultimately gradation of online bookstores was achieved in both method. Although the weights of each criterion was calculated differently, the ranking of performances were identical in two methods.

This paper performed by single expert opinion which reflects behavior of customer that shops online. Thereby for the further studies group decision making can be measure the potential customer mass by one of the method in literature. In addition various shopping websites that is in the strong competition can be evaluated in terms of different variables. By the help of the results managers of websites can strengthen the weak parts of business.

REFERENCES

Anand, G. & Kodali, R. (2008). Selection of Lean Manufacturing Systems Using the PROMETHEE. *Journal of Modelling in Management*, 3(1), 40-70.

Araz, C. & Ozkarahan, I. (2007). Supplier Evaluation and Management System for Strategic Sourcing Based On a New Multicriteria Sorting Procedure. *International Journal of Production Economics*, 106, 585-606.

Bana e. Costa, C. A. & Vansnick, J. C. (1994). MACBETH- An Interactive Path towards the Construction of Cardinal Value Function. *International Transactions in Operational Research*, 1(4), 489-500.

Bana e. Costa, C. A. & Vansnick, J. C. (1997a). Applications of the Macbeth Approach in the Framework of an Additive Aggregation Model. *Journal of Multi-criteria Decision Analysis*, 6, 107-114.

Bana e. Costa, C. A. & Vansnick, J. C. (1997b). *The Theoretical Framework for Measuring Attractiveness by a Categorical Based Evaluation Technique (MACBETH). In Multicriteria Analysis*. Springer Berlin Heidelberg.

Bana e Costa & Vansnick (1999). *Advances in Decision Analysis* (Vol. 4). Ed. Meskens, N., & Roubens, M. R. Springer Science & Business Media.

Bana e. Costa, C. A., De Corte, J. M. & Vansnick, J. C. (2005). *Software M-MACBETH Version 1.1*, European Working Group "Multiple Criteria Decision Aiding" 3(12); Download date: 27.03.2016, http://www.inescc.pt/~ewgmcda/SW_M_Macbeth.pdf.

Bastida, U. & Huan, T. C. (2014). Performance Evaluation of Tourism Websites' Information Quality of Four Global Destination Brands: Beijing, Hong Kong, Shanghai, and Taipei. *Journal of Business Research*, 67, 167-170.

Bhushan, N. & Rai, K. (2004). *Strategic Decision Making Applying the Analytic Hierarchy Process*, 1st Edition, London: Springer.

Brans, J. P. & Vincke, P. (1985). A Preference Ranking Organization Method. *Management Science*, 31(6), 647-656.

Brans, J. P., Vincke, P. & Mareschal, B. (1986). How to Select and How to Rank Projects: The Promethee Method. *European Journal of Operational Research*, 24, 228-238.

Brans, J. P., & Mareschal, B. (2005). *PROMETHEE Methods. In Multiple Criteria Decision Analysis: State of The Art Surveys*. Springer New York.

Brunelli, M. (2015). *Introduction to the Analytic Hierarchy Process*, New York: Springer.

Büyüközkan, G., Ruan, D. & Feyzioğlu O. (2007). Evaluating E-Learning Website Quality in a Fuzzy Environment. *International Journal of Intelligent Systems*, 22, 567-586.

Cao, M., Zhang, Q. & Seydel, J. (2005). B2C E-Commerce Website Quality: An Empirical Examination. *Industrial Management & Data Systems*, 105(5), 645-661.

Chandran, B., Golden, B. & Wasil, E. (2005). Linear Programming Models for Estimating Weights in the Analytic Hierarchy Process. *Computers & Operations Research*, 32, 2235-2254.

Chang, C. W., Wu, C. R., Lin, C. T. & Chen H. C. (2007). An Application of Ahp and Sensitivity Analysis for Selecting the Best Slicing Machine. *Computers& Industrial Engineering*, 52, 296-307.

Chiu, W. Y., Tzeng, G. H. & Li, H. L. (2013). A New Hybrid Mcdm Model Combining Danp and Vikor to Improve E-Store Business. *Knowledge-Based Systems*, 37, 48-61.

Clivillé, V., Berrah, L. & Mauris G. (2007). Quantitative Expression and Aggregation of Performance Measurements Based on MACBETH Multi-Criteria Method. *International Journal of Production Economics*, 105, 171-189.

Dağdeviren, M. (2008). Decision Making in Equipment Selection: An Integrated Approach with AHP and PROMETHEE. *Journal of Intelligent Manufacturing*, 19(4), 397-406.

Dhouib, D. (2014). An Extension of Macbeth Method for a Fuzzy Environment to Analyze Alternatives in Reverse Logistics for Automobile Tire Wastes. *Omega*, 42, 25-32.

Ertay, T., Kahraman, C. & Kaya İ. (2013). Evaluation of Renewable Energy Alternatives Using MACBETH and Fuzzy AHP Multicriteria Methods: The Case of Turkey. *Technological and Economic Development of Economy*, 19(1), 38-62.

Ertuğrul, İ. & Özbay, B. (2013). Supply Chain Optimization and Distribution Network Application with AHP in a Yarn Company. *Tekstil ve Konfeksiyon*, 23(2), 87-93.

Ertuğrul, İ. & Tanrıverdi, Y. (2013). Stok Kontrolde ABC Yöntemi ve AHP Analizlerinin İplik İşletmesine Uygulaması. *International Journal of Alanya Faculty of Business*, 5(1), 41-52.

Frenette, C. D., Beauregard, R., Abi-Zeid, I., Derome, D. & Salenikovich A. (2010). Multicriteria Decision Analysis Applied to the Design of Light Frame Wood Wall Assemblies. *Journal of Building Performance Simulation*, 3(1), 33-52.

Gass, S. I. & Rapcsak, T. (2004). Singular Value Decomposition in AHP. *European Journal of Operational Research*, 154, 573-584.

Geldermann, J., Spengler, T. & Rentz O. (2000). Fuzzy Outranking for Environmental Assessment. Case Study: Iron and Steel Making Industry. *Fuzzy Sets and Systems*, 115, 45-65.

Hanfield, R., Walton, S. V., Sroufe, R. & Melnyk S. A. (2002). Applying Environmental Criteria to Supplier Assessment: A Study in the Application of the Analytical Hierarchy Process. *European Journal of Operational Research*, 141, 70-87.

Kang, D., Jang, W. & Park Y. (2016). Evaluation of E-Commerce Websites Using Fuzzy Hierarchical TOPSIS Based on E-S-QUAL. *Applied Soft Computing*, 42, 53-65.

Karande, P. & Chakraborty S. (2013). Using MACBETH Method for Supplier Selection in Manufacturing Environment. *International Journal of Industrial Engineering Computations*, 4, 259-272.

Keyser, W. D. & Peeters P. (1996). A Note on the Use of PROMETHEE Multicriteria Methods. European Journal of Operations Research, 89, 457-461.

Ku, E. C. S. & Fan Y. W. (2009). The Decision Making in Selecting Online Travel Agencies: An Application of Analytic Hierarchy Process. *Journal of Travel& Tourism, 26(5-6)*, 482-493.

Macharis, C., Springael, J., De Brucker, K., & Verbeke, A. (2004). PROMETHEE and AHP: The Design of Operational Synergies in Multicriteria Analysis: Strengthening PROMETHEE with Ideas of AHP. *European Journal of Operational Research*, *153*(2), 307-317.

Ngai, E. W. T. (2003). Selection of Websites for Online Advertising Using the AHP. *Information & Management*, 40, 233-242.

Rao, R. V. & Patel B. K. (2010). Decision making in the Manufacturing Environment Using an Improved PROMETHEE Method. *International Journal of Production Research*, 48(16), 4665-4682.

Saaty, T. L. (1987). The Analytic Hierarchy Process- What It is and How It is Used. *Mathematical Modelling*, 9(3-5), 161-176.

Saaty, T. L. (2008). Relative Measurement and It's Generalization in Decision making Why Pairwise Comparisons are Central in Mathematics for the Measurement of Intangible Factors- the Analytic Hierarchy/ Network Process. RACSAM, 102(2), 251-318.

Saaty, T. L. & Vargas, L.G. (2001*). Models, Methods, Concepts & Applications*, New York: Springer.

Salmeron, J. L. & Herrero I. (2005). An AHP-based Methodology to Rank Critical Success Factors of Executive Information Systems. *Computer Standards& Interfaces, 28*, 1-12.

Schäfer, K., & Kummer, T. F. (2013). Determining the Performance of Website-Based Relationship Marketing. *Expert Systems with Applications, 40(18)*, 7571-7578.

Sugihara, K., Ishii, H. & Tanaka H. (2004). Interval Priorities in AHP by Interval Regression Analysis. *European Journal of Operational Research, 158*, 745-754.

Tsai, W. H., Chou, W. C. & Lai C. W. (2010). An Effective Evaluation Model and Improvement Analysis for National Park Websites: A Case Study in Taiwan. *Tourism Management, 31*, 936-952.

Tsai, W. H., Chou, W. C. & Leu J. D. (2011). An Effective Evaluation Model for the Web-Based Marketing of the Airline Industry. *Expert Systems with Applications, 38,* 15499-15516.

Wang, J. J. & Yang D. L. (2007). Using a Hybrid Multi-Criteria Decision Aid Method for Information Systems Outsourcing. *Computers & Operations Research, 34*, 3691-3700.

Wang, X., Gao, Z. & Wei G. (2011). An Approach to Archieves Websites' Performance Evaluation in Our Country with Interval Intuitionistic Fuzzy Information. *Advances in Information Sciences and Service Sciences, 3(7)*, 112-117.

Wu, J. & Guo, D. (2015). Measuring E-government Performance of Provincial Government Website in China with Slacks-based Efficiency Measurement. *Technological Forecasting & Social Change, 96,* 25-31.

Zahedi, F. (1986). A Simulation Study of Estimation Methods in the Analytic Hierarchy Process. *Socio-Economic Planning Sciences, 20(6),* 347-354.

Zeshui, X. & Cuiping, W. (1999). A Consistency Improving Method in the Analytic Hierarchy Process. *European Journal of Operational Research, 116,* 443-449.